SIX DOLLARS

A CAHNERS PUBLICATION

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER & SYSTEMS COMPANIES — WORLDWIDE

SEPTEMBER 3, 1990

DEFENSE BUSINESS UNDER FIRE

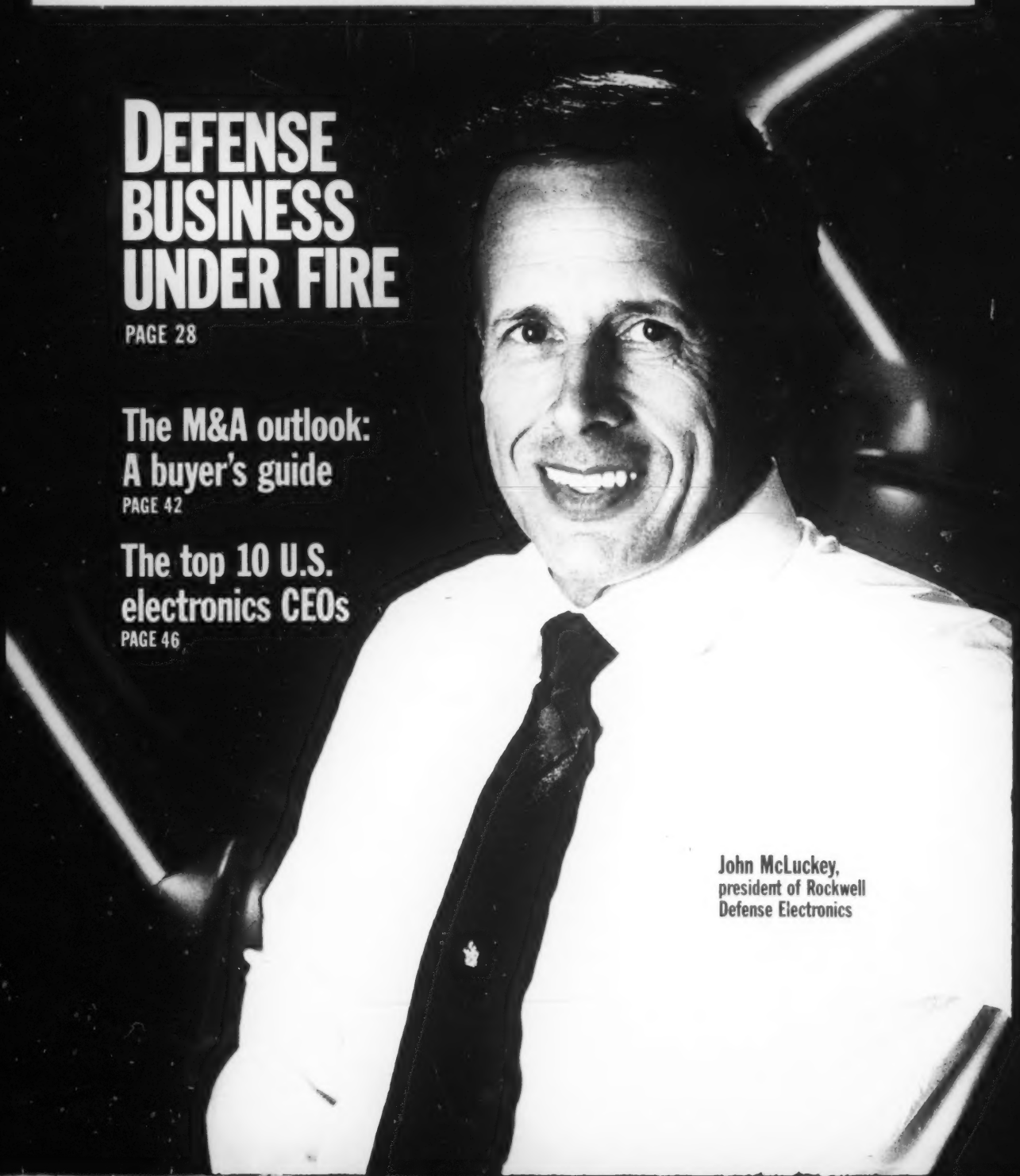
PAGE 28

The M&A outlook: A buyer's guide

PAGE 42

The top 10 U.S. electronics CEOs

PAGE 46



John McLuckey, president of Rockwell Defense Electronics

Electronic Business

FOR MANAGEMENT IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES—WORLDWIDE

VOL. 16, NO. 17

SEPTEMBER 3, 1990

Cover photograph: Gary Galvin

PAGE 28 John A. McLuckey of Rockwell Defense Electronics: A diversity of products and services helps offset budget cuts

COVER STORY/DEFENSE ELECTRONICS

28 Tracking the changing defense electronics market

Defense electronics may escape the worst of the U.S. military budget cuts, but, as one supplier put it, "there's going to be a lot of pain." Last year's predictions of a 2% real decline in U.S. defense spending may have to be doubled, thanks to the virtual end of the cold war. To help ease the pain, defense electronics suppliers are diversifying and developing dual-use technologies.

UPDATE

11 Business Trends
Lawsuit may cool Japanese investors' ardor; Philips ponders reduced role in JESSI; modern-art museum salutes the microchip; Fujitsu deal worries Europeans; minicomputer makers share the misery; distributor Avnet ends an era; Shanghai courts U.S. electronics investment; telecom acquisition moves DSC into the local loop.

21 Companies to watch
Poquet creates a one-pound PC; Gigatape uses DAT for data backup; In Focus combines a computer screen and overhead projector.

23 Commentary/Outsourcing
Contracting to service the huge U.S. base of corporate computer equipment provides opportunities that are attracting hardware manufacturers and service companies alike, according to consulting editor Alberto Socolovsky.

COVER STORY/DEFENSE ELECTRONICS

28 Tracking the changing defense electronics market
Defense electronics companies that pursue a business-as-usual strategy may not be around for long, and for survivors, narrower profit margins and increased competition will likely be the rule. But electronics vendors are finding ways to deal with the new realities of the defense market.

31 Defense electronics a tough sell in international markets
With the domestic market shrinking, U.S. defense-electronics suppliers are looking overseas for sales. Succeeding abroad, however, will require intensive study and new strategic partnerships.

33 Military semiconductor sales growing, market share declining
While the defense share of the U.S. semiconductor market is decreasing and semiconductor prices are eroding, the increasing semiconductor content of defense systems creates opportunities for those selling to the right market.

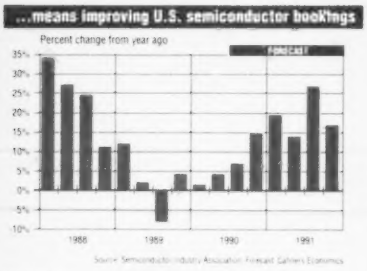
STRATEGIES

38 AMP connects its once and future goals
The United States' largest connector maker hopes to regain past performance levels. AMP Inc. has set a goal of returning to the 15% growth of the 1970s in an industry that's now growing only 7% to 9% a year. AMP's strengths may put the goal within its reach.

MANAGING RESOURCES

42 A good M&A is getting hard to find
The merger-and-acquisition market is growing selective, as the takeover frenzy of the late 1980s leaves many more companies on the block than there are qualified buyers. Companies desperate for cash face a tough time putting M&A deals together.

PAGE 68 Intel Japan president William Howe: "Companies are seeking to share resources"



PAGE 90 Semiconductor bookings up

PAGE 11 Japan's US investment may be chilled after Stardent's embarassing legal battle

PAGE 63 Viewlogic's Kanti Purohit: Facing tough competition in the European market

PAGE 11 Edward Kaniger: Gone from Hamilton/Avnet

PAGE 38 AMP chairman Harold McInnes: Strong companies will get stronger

MANAGING RESOURCES

46 Electronic Business picks the top 10 U.S. executives
What makes a great electronics CEO? Nimbleness, a strong business sense and the ability to create and maintain a corporate culture. From a galaxy of star executives, ELECTRONIC BUSINESS editors pick the 10 best.

57 Top paid U.S. executives
Revenues were flat, profits were down and indebtedness was up in 1989, but the best-paid U.S. electronics executives continued to rake it in. The number of $1 million-a-year execs nearly doubled.

EUROPE BUSINESS

63 Viewlogic grows in Europe, protects earnings at home
For a U.S. company planning to go public, expanding in Europe is a risky business. This Massachusetts software company says it has found a way to finance expansion and protect its bottom line by using European capital.

ASIA/PACIFIC BUSINESS

68 Foreign alliances that make sense
More and more, U.S. and Asian companies are forging alliances for semiconductor ventures in order to obtain technology and financing, tap new markets and avoid protectionism. The trend makes for some interesting partnerships.

MARKET PERSPECTIVES

75 ATE leaders get competition from below
Automatic test equipment traditionally has been a high-priced, high-performance business. That's changing, as a new generation of sophisticated mixed-signal testers is attracting customers in search of the cheapest configurations they can find.

81 For single-board makers, the future is Futurebus+
The move to an open-standard bus architecture will mean big business for single-board computer makers as systems houses try to keep R&D costs down while keeping up with demand for higher performance.

BUSINESS BAROMETER

90 **Semiconductor**
Industry on the rebound

91 **Leading indicator**
Indicator holds steady

DEPARTMENTS

7 **Inside Business**

87 **My View**
Slam-dunk time and leadership

89 **Advertiser index**

92 **Viewpoint**
The legacy of Adam Smith

COMPANIES IN THIS ISSUE

88 **An index of the companies covered in this issue.**

EDITORIAL STAFF

Publisher: Frank J. Burge

Editor: Jeffrey Bairstow

Managing Editors: H. Garrett DeYoung, Bruce C.P. Rayner

Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland

Associate Editor: Peter L. Burrows

Assistant Editors: Barbara Jorgensen, Xiong Xiaoge, Giuseppe Labianca

Section Editor: John W. Parker

Contributing Editors: Elizabeth Baatz (Cahners Economics), Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Charles L. Cohen (Tokyo), Ray Wise (New York), Julie Handelman (Cahners Economics), Nancy Rutter (San Francisco), Linda Bernier (Brussels), Paula Doe (Seattle)

Consulting Editors: Alberto Socolovsky, Allen Furst

Senior Production Editor: Karen J. Covey

Assistant Production Editor: Maura A. Baker

Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach

Associate Art Director: Carla Aguilar Leeder

Staff Artist: Michele G. Kane

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, Mass. 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

Washington, D.C.: Pam Nazaruk
1333 F Street, N.W., Suite 720
Washington, D.C. 20004 (703) 960-4549

San Jose, Calif.: Teri Sprackland
Sherman Building, 3031 Tisch Way, Suite 100
San Jose, Calif. 95128 (408) 296-0868

Northwest: Dwight B. Davis
2924 Queen Anne Ave., N.
Seattle, Wash. 98109 (206) 284-5130

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky

Director of Production/Manufacturing: John R. Sanders

Production Supervisor: Andrew A. Jantz

Production Manager: Betsy Harkins; (617) 964-3030

CIRCULATION

Circulation Manager: Ann Ward
44 Cook Street, Denver, Colo. 80206
(303) 388-4511

Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, Ill. 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, Mich. 48106

Whither DE in the '90s?

Northrop has spent lots of money lately on an advertising campaign to rally public support for its B-2 stealth bomber. Lockheed is doing the same now for its advanced tactical fighter, the ATF. Both companies face doom if these high-profile planes are cut by Congress.

They are not alone. Defense electronics companies — subcontractors to the Lockheeds and Northrops of this world — are also being wrenched apart by events beyond their control. Namely, the end of the cold war and the need to cut the federal deficit. As B-2s get slashed, DE players get burned. The razing has just begun.

Senior editor Rick Whiting takes a detailed look at the changes sweeping through the defense electronics industry and details strategies for survival in this era of defense cuts. While the writing has been on the wall for a year or two, many DE companies are just now codifying their business plans for the new environment. How will they fare in the '90s and how can they increase their chances for survival?

Rick digs below the surface to uncover the answers. He looks at some of the big players, like Rockwell (cover photo), as well as some smaller players. What he finds is a lot of soul-searching and some widely divergent strategies.

Senior editor Rick Whiting

What is so important about his story is that the lessons are not exclusively for the benefit of defense firms. Any company faced with a rapidly changing market — and that goes for just about all our readers — can gain some insight from this piece.

The rich and famous

Also in this issue are two very important lists: Salaries for the top 100 electronics executives, compiled by senior editor Linda Stallmann, and the ELECTRONIC BUSINESS annual pick of the 10 best electronics executives, written by contributing editor Nancy Rutter. This is your chance to drool over the paychecks of the likes of John Sculley and Rod Canion. Sculley took home $2.25 million last year; Canion made $2.1 million.

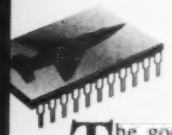
But money wasn't enough to make the exclusive 10 best execs list. Canion made it; Sculley didn't. We were after the well-rounded CEO: strong personality, exceptional leadership qualities and the ability to translate these characteristics into results.

If you are not listed either in the 100-top-paid or the 10-best list, we urge you not to lose hope. There is always next year. Alternatively, you could write us a letter and complain. We love that.

BRUCE C.P. RAYNER, managing editor

ELECTRONIC BUSINESS® (ISSN 0163-6197) is published twice a month, except monthly in December, by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President; Frank Sibley, Senior Vice President/General Manager, Boston Division; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. POSTMASTER: Send address corrections to ELECTRONIC BUSINESS®, 44 Cook Street, Denver, CO 80206-5800. ELECTRONIC BUSINESS® copyright 1990 by Reed Publishing USA; Ronald G. Segel, Chairman and Chief Executive Officer; Robert L. Krakoff, President and Chief Operating Officer; William M. Platt, Senior Vice President. Annual subscription rates for non-qualified people: USA, $79.95; Canada, C $99.95; other countries, $120 per year; $100, air mail surcharge. Except for special issues where price changes are indicated, single copies of regular issues are available for $10.00 (USA, Canada/Mexico and foreign). Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Home Furnishings • Interior Design. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning.

BPA ABP



Military chip sales grow, market share shrinks

The good news is that the semiconductor content of defense systems is increasing and sales of semiconductors for military applications are expected to grow well into the 1990s.

The bad news is that the defense share of the overall semiconductor market is shrinking and military semiconductors are experiencing price erosion.

The percentage of U.S.-made semiconductors sold for military use has dropped from as high as 80% in the 1960s to about 10% or $1.7 billion of this year's estimated $17.2-billion North American semiconductor market, according to Greg Sheppard, an industry analyst for Dataquest Inc.

Top 10 military IC suppliers

Rank	1989 Company	1989 Sales ($M)	1988 Company	1988 Sales ($M)
1	Harris	280	Harris	275
2	National	255	National	245
3	TI	160	TI	155
4	AMD	142	AMD	155
5	Motorola	92	Motorola	90
6	LSI Logic	82	LSI Logic	80
7	Intel	75	Intel	70
8	IDT	70	Raytheon	55
9	Raytheon	57	Analog Dev.	42
10	Micron	42	Honeywell	40
	Other	345	Other	338
	Total	1,600	Total	1,545

Source: Integrated Circuit Engineering Corp

Despite expected annual growth of 4% to 5% in the military semiconductor arena, semiconductors sold for military use will account for only $2.2 billion or 6% of the total $35 billion North American semiconductor market by 1995, Sheppard projects. Semiconductor sales for commercial use are growing about three times faster than defense-related sales.

Nevertheless, such areas as simulation equipment and space systems will show increased demand for semiconductors. Johari Associates, a Colorado Springs market research firm, projects that semiconductor sales for simulation equipment will grow 12% annually between now and 1994, from $100 million to $161 million. Other military market segments, such as communications and electronic warfare, will show yearly semiconductor sales growth in the 5% to 6% range.

"Because the semiconductor content in these systems is increasing, it helps offset cuts in the defense budget," says Jim Harding, military sales manager at Micron Technologies Inc. in Boise, Idaho, which manufactures dynamic RAMs for military use. Defense already accounts for 5% to 8% of Micron's sales. By targeting sales for weapon system upgrades rather than new programs, the company hopes to boost that to 12% to 15%.

"If you're in the right market segments, you're going to do O.K.," says Bob G. Quinn, vice president of strategic marketing, military and aerospace at Harris Semiconductor in Melbourne, Fla. Quinn says that Harris, whose customers include Raytheon, Northrop and Rockwell International, is focusing sales efforts on military and commercial space and aerospace applications. About one-third, or $280 million, of Harris's semiconductor sales go for military use, making it the largest vendor in that market.

Leading-edge defense systems for surveillance and satellites will need leading-edge technology, according to W.T. Greer Jr., Motorola Inc.'s director of military products operations. So vendors that supply state-of-the-art semiconductors will win the business. Greer also foresees closer alliances and technology sharing between chip makers and the system manufacturers they supply.

The military market is also seeing its share of semiconductor and component price erosion. "There have been considerable price pressures in commodity semiconductors and older technologies in the military market," Quinn says. Harris's strategy is to remain at the high end of the market to avoid pricing pressures. □

workstations for industrial use.

The plan is expected to increase HP's presence in the military computer market while Hughes can extend its expertise into commercial industrial areas. The alliance is expected to result in sales of $200 million over the next few years.

"The old days when a company did everything itself are fading," says E.O. Knowles, a Hughes assistant division manager who will oversee the new subsidiary. "You need these kinds of alliances."

Despite all the ideas for dealing with the defense spending slowdown, corporate managers emphasize that the most important strategy is not to overlook the basics like product quality. As primary defense contractors cut back their lists of suppliers, vendors that fail to meet their customers' needs will be the first to go.

Using total quality management (TQM) and product-cycle time management practices, Rockwell has streamlined its cost structures and realized efficiencies of 20% to 40%, according to McLuckey. TQM helped Rockwell turn around a financially troubled missile operation in Georgia, and McLuckey attributes a recent win over Martin Marietta Corp. for a major antiarmor missile contract to cost savings realized with TQM.

"Pick your opportunities wisely, get close to your customers and determine the real need for products" is the advice offered by TI's Horsley. "Learn to get real competitive. And you get competitive by building a top quality product at a competitive price. Those are the ABCs of good business, but I guess we need to revisit them once in a while." □

A good M&A is getting hard to find

Equity is expensive, so is debt and now the mergers and acquisition market is growing selective. Companies desperate for cash face a tough time putting deals together in 1990

BY RAY WISE

The space between the rock and the hard place is narrowing. For the unlucky U.S. entrepreneurs unable to corral foreign capital, domestic alternatives are becoming mighty tough to find. Venture capitalists have grown wary of the high technology sector; the IPO market has been soft ever since the stock market crashed in October, 1987; and now merger and acquisition dealmaking — the last haven of easy-to-find capital — is turning selective.

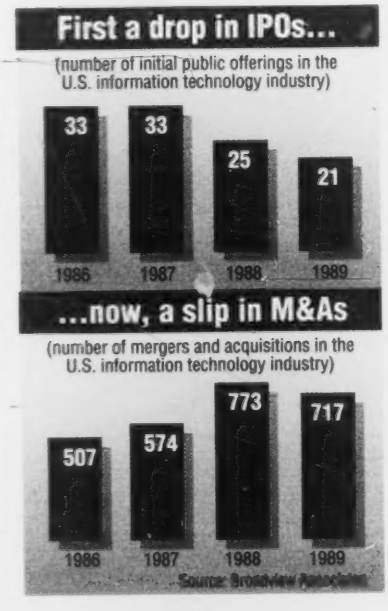
M&A activity was up last year in several high tech sectors but the information technology industry overall showed a 7.2% decline to 717 transactions from 773 in 1988, according to Broadview Associates, a Fort Lee, N.J., investment banking firm specializing in mergers and acquisitions in the IT industry. What's more, the slide in M&A activity is expected to continue this year, according to George Grodahl, a Broadview partner.

Both M&As and equity offerings have been exhibiting wild swings lately. While the number of M&As may be slowing there were still 41% more deals completed in the information technology sector in 1989 than were transacted three years earlier. Over the same time period the number of initial public offerings dropped 24%. "Selling companies to get value is an actively sought alternative [to IPOs]," says George Von Gehr of the investment banking firm of Von Gehr & Tan, Palo Alto, Calif.

The byproduct of the takover frenzy in the late 1980s is that there are now many more companies on the block than there are qualified buyers. As a result, prices are down and buyers are growing selective. "I would characterize M&As as a buyers' market," says Steve Kahn, vice president of AI Financial Service, a wholly owned subsidiary of Advent International, a Boston-based venture capital firm.

Some potential buyers are reconsidering whether they want to acquire at all. In some cases that is because they overpaid in the past, says Kahn. A classic case was the January, 1985, acquisition of CAE Systems Inc., of Sunnyvale, Calif. by Tektronix Inc. of Beaverton, Ore. for $75 million. Three years later, Tektronix sold CAE to Mentor Graphics Corp. for $5 million.

While buyers are growing wary, sellers flock to the market as the M&A route increasingly becomes the method of choice for new capital. Because there are so many sellers chasing fewer buyers, "it gets harder and harder to do these M&A deals," complains Grodahl.



M&A deals take nine to 15 months to complete these days compared with three to nine months two years ago. This reflects buyers' improved bargaining position and increasing selectivity. Even auction deals, in which the investment banker solicits buyer's bids for a venture, have become hard to implement.

"These days auctions are used only to sell top companies," notes Von Gehr. A recent example is the auction of Spectra-Physics Inc., the San Jose, Calif.-based laser maker, by Ciba-Geigy Ltd., a diversified Swiss corporation, to Nobel Industries AB, a Swedish pharmaceuticals company. Except for big or unique companies, most deals require painstaking head-to-head negotiating.

VC money not the answer

Of course, top-notch technology companies still draw financing, as they always have. But even where venture capital is available, it may not be the answer. Grodahl argues that the entrepreneur often confronts the question: "If marketing is my problem, is money necessarily the solution?" Some emerging companies bypass the venture capital community entirely, advancing directly from angel financing to a merger or acquisition. The reason is access to an existing marketing channel.

Not that venture capitalists are all that receptive. They have less money to invest, and they are saving it for the choice companies in their portfolios. In fact, the amount of money raised by the venture capital industry has declined by at least 25% in each of the last two years, according to Hambrecht & Quist, an investment banking firm in San Francisco.

Another factor driving entrepreneurs into the M&A marketplace is the wariness prevailing among com-

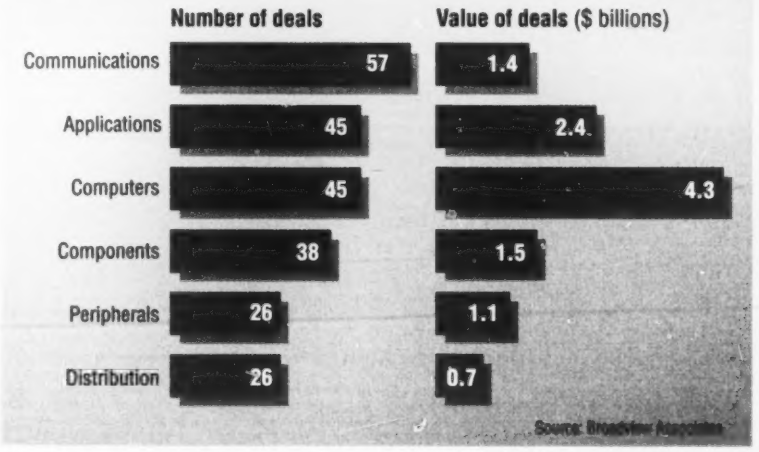
mercial banks, many of which are leveraged up to their necks in real estate, Third World debt or both. "The banks are not too receptive [to financing high technology companies]," reports David Jacobs, vice president of Shea, Paschall & Powell Co., investment banking concern based in New York.

The typical company clamoring for an M&A deal might have qualified for an initial public offering in the frothy days of 1983 but not today. A shockingly large number of the early 1980s IPO boomers that are still in business have performed very poorly in the stock market. Broadview figures that of the 209 IPO's that have been launched since 1983 in the information technology field, 135, or 65%, have lost value in the stock market while 34% have depreciated more than 75% from their initial offering prices. Not surprisingly, very few of these outfits have been able to raise equity capital in secondary public offerings.

Even software companies —among some of the most optimistic IPOs back in the early '80s — are suffering in the M&A market. A total of 215 software deals were cut in 1989, down 13% from the year-earlier 247. However, reflecting a fairly large median transaction size of $5 million, the dollar value of software deals climbed 31% last year to $3.4 billion from $2.6 billion in 1988. Applications software accounted for 64% of the 1989 transactions, while systems products had the remaining 36%.

Activity is still strong in hardware, however. There were 237 hardware M&A deals in 1989, a gain of nearly 10 percent over the year-earlier 216, and dollar value edged up to $11.4 billion from the $10.2 billion of 1988. Among the big transactions were: J.H Whitney's & Co. leveraged buyout of Prime Computer Inc. for $1.3 billion; Hewlett-Packard Co.'s acquisition of Apollo Computer Inc. for $476 million; and Seagate Technology Inc. purchase of Imprimis Technology from Control Data Corp. for $450 million.

1989 M&A deals in the U.S. hardware market



Small deals dominate

In volume terms, it was the smaller deals that dominated last year. And this year, investment bankers are reporting an uptick in mergers between fairly small companies of comparable size competing in the same marketplace. The rationale for merging is economics of scale and the elimination of redundancies. James D. Timmins, a principal at Hambrecht & Quist, reports a proliferation of these transactions in software. The sharply declining cost of platform power has lured a legion of fledgling software writers into the marketplace, many with little distribution clout. So they pool resources through merging.

Many of these mergers go unreported because they are private. But one example is a deal Von Gehr put together last year between Data Design Associates and Integral Systems, two Northern California software companies. The two companies complemented each other well as they are both mainframe and minicomputer software suppliers, according to Von Gehr.

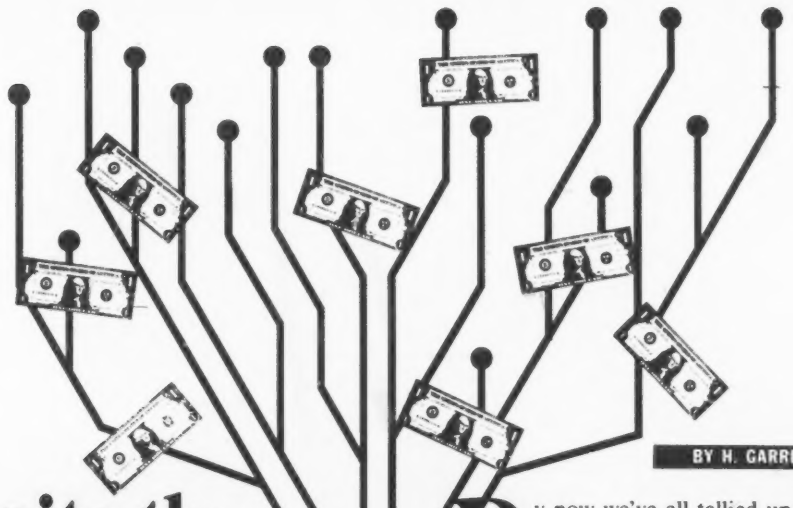
Early planning helps to develop the right strategy to maximize the company's value

Another area of heavy merger activity is in the disk drive market, says John W. Ulrich, senior vice president of 3i Capital Corp., a venture firm in Newport Bech, Calif. Two manufacturers of recording heads for Winchester disk drives, Computer & Communications Technology Corp. and Sunward Technologies, have agreed in principle to merge and consolidate their administrative operations in San Diego, Calif. The deal is expected to slash manufacturing and operating expenses and bolster the combined balance sheet with the addition of Sunward's $6.5 million cash position. Aggregate annual revenue would be $100 million. "The merger was born of pressures on the companies to reduce price," according to Ulrich. "It's tough out there."

The tough environment adds another dimension to the entrepreneur's business plan, the need to plan for the sale or public offering right from the creation of the company, says Von Gehr. To develop the right strategy that will maximize the value of the company either in the M&A market or the IPO market means plans have to be made very early on. "Think of yourself as having a strategy to create liquidity, as well as product development, marketing and manufacturing," the investment banker advises.

Some see the IPO window to liquidity opening this year. One optimist is DuBose Montgomery of Menlo Ventures, Menlo Park, Calif. A healthier IPO market would clear the way for more entreprenuers to obtain the best investment returns on the companies they labored so hard to build. "Go public, *then* sell," he recommends.

In today's climate, though, that may be easier said than done. □



BY H. GARRETT DeYOUNG

Despite the industry blues, the rich got even richer in '89

Compared to salaried employees, top managers of electronics companies enjoyed bountiful raises last year, nearly doubling the enrollment of the $1 million-a-year club

By now we've all tallied up the grim numbers from 1989: Revenues for leading U.S. electronics companies rose by a meager 4% — the lowest increase since 1986 — and net income slipped by 0.7%. Moreover, long-term indebtedness among the companies that make up the ELECTRONIC BUSINESS 200 rose nearly 15% last year to $182.6 billion.

Still, the 100 top paid execs at publicly held U.S. electronics companies posted an average 8.4% pay hike for 1989, up from 4.6% in 1988. By comparison, U.S. salaried workers can plan on an average increase of 5% this year, according to The Conference Board in New York City.

Seventy-nine of the 100 electronics executives took increases ranging from 319% for Francis J. Gaudette, senior vice president of Microsoft Corp., whose salary is now $790,687, to 0.1% for Alan F. Shugart, CEO of Seagate Technology Inc. Two executives on the list — Motorola Inc.'s Robert W. Galvin and Dataproducts Corp.'s Jack C. Davis — stood pat from 1988, and 19 took pay cuts. W. Michael Blumenthal, chairman and then-CEO of Unisys Corp., took the biggest cut of all: 49.5%.

The only surprise in this year's list is the near doubling of the membership in the industry's million-dollar club. Only 11 executives earned $1 million or more in 1988; the number is now 20.

There were few changes in top rankings. The first three names on this year's list, for example, are the same as last year's: Apple Computer Inc.'s John Sculley, Compaq Computer Corp.'s Joseph R. (Rod) Canion and Computer Associates International Inc.'s Charles B. Wang. As for IBM Corp. chairman John F. Akers, his 6.9% salary cut to $1.42 million landed him in the number 11 position this year, down from number 5 in 1988.

The ELECTRONIC BUSINESS ranking of executive pay is based on the companies' most recent proxy statements and reports cash compensation only, including bonuses. The tables on pages xx and xx do not reflect salary or title changes that have occurred since the close of the companies' 1989 fiscal year. □

Top paid U.S. executives

Rank	Executive/age	1989 Cash compensation	Percentage change from 1988	Company	Position
1	**John Sculley**/50	$2,251,175	-9.2%	Apple Computer	Chairman, President, CEO
2	**Joseph R. Canion**/44	2,114,955	13.3%	Compaq Computer	President, CEO
3	**Charles B. Wang**/45	1,956,512	9.1%	Computer Associates	Chairman, CEO
4	**David G. Sadler**/51[1]	1,911,953	308.0%	Savin	Chairman, CEO, COO
5	**Bernard L. Schwartz**/63	1,742,009	20.4%	Loral	Chairman, CEO
6	**Lawrence J. Ellison**/45	1,734,375	27.3%	Oracle	President, CEO
7	**Anthony W. Wang**/47	1,683,512	10.7%	Computer Associates	President, COO
8	**Cyrril J. Yansouni**	1,670,050	NA	Unisys	Sr. VP
9	**John A. Young**/57	1,584,699	18.1%	Hewlett-Packard	President, CEO, Chairman
10	**Paul C. Ely, Jr.**[2]	1,537,677	NA	Unisys	Executive VP
11	**John F. Akers**/55	1,420,713	-6.9%	IBM	Chairman
12	**James J. Renier**/60	1,366,165	137.8%	Honeywell	Chairman, CEO
13	**David T. Kearns**/59	1,333,318	43.6%	Xerox	Chairman, CEO
14	**Charles E. Exley, Jr.**/60	1,166,000	9.0%	NCR	Chairman, CEO
15	**Frank G. Hickey**/61	1,093,450	17.9%	General Instrument	Chairman, CEO
16	**John T. Hartley**/59	1,075,972	9.4%	Harris	Chairman, President, CEO
17	**Ward D. Parkinson**/44[3]	1,059,968	47.4%	Micron Technology	Vice Chairman
18	**Joseph L. Parkinson**/44	1,034,815	49.7%	Micron Technology	Chairman, CEO
19	**Norman L. Harritt**/48[4]	1,019,190	302.0%	Savin	Executive VP, CFO
20	**Dean O. Morton**/57	1,002,637	19.3%	Hewlett-Packard	Executive VP, COO, Director
21	**Stewart Carrell**/56	998,883	157.2%	Diasonics	Chairman, CEO
22	**Jim P. Manzi**/38	991,358	80.2%	Lotus	Chairman, President
23	**Eckhare Pfeiffer**/47	990,656	10.9%	Compaq Computer	President, Europe & International
24	**Dan Maydan**	987,513	NA	Applied Materials	Group VP
25	**John V. Roach**/50	970,710	11.4%	Tandy	Chairman, CEO, President
26	**Kenneth H. Olsen**/63	949,592	1.9%	Digital Equipment	President, Director
27	**Leon Machiz**/65	925,992	2.4%	Avnet	Chairman, CEO, President, COO
28	**Ryal R. Pappa**/56	925,631	36.4%	Storage Technology	Chairman, CEO, President
29	**Frank C. Lanza**/57	919,310	7.4%	Loral	President, COO
30	**Jack D. Kuehler**/57	918,190	-5.3%	IBM	President
31	**Paul A. Allaire**/51	916,181	46.0%	Xerox	President
32	**William W. Lane**/55	904,944	11.4%	Emerson Radio	Chairman
33	**Stephen L. Lane**/53	904,941	11.4%	Emerson Radio	President
34	**W.J.Sanders III**/52	878,883	19.0%	Advanced Micro Devices	Chairman, CEO
35	**William E. Johnson**/47	874,715	30.3%	Scientific-Atlanta	Vice Chairman, CEO
36	**David T. Mitchell**/47	874,193	-11.9%	Seagate Technology	President, COO
37	**John C. Lewis**/54	865,346	-6.9%	Amdahl	Chairman, CEO
38	**Jarome Swartz**/49	863,141	21.6%	Symbol Technologies	Chairman, CEO
39	**George B. Harvey**/58	862,688	0.5%	Pitney Bowes	Chairman, President, CEO
40	**John F. Mitchell**/61	845,604	12.5%	Motorola	Vice Chairman
41	**W. Michael Blumenthal**/64	839,900	-49.5%	Unisys	Chairman, CEO
42	**Robert M. Price**/59	834,957	-3.2%	Control Data	Chairman, CEO
43	**Dennis C. Fill**/61	818,426	30.1%	Westmark International	Chairman, CEO, President
44	**Melvin Howard**/55	817,844	-35.6%	Xerox	Vice Chairman
45	**Douglas K. Mahon**/48	800,754	1.6%	Seagate Technology	Executive VP, Chief Technical Officer
46	**Francis J. Gaudette**	790,687	319.2%	Microsoft	Sr. VP
47	**Ruediger Naumann-Etienne**/43	789,228	287.2%	Diasonics	President, COO
48	**James L. Donald**/58	786,996	7.5%	DSC Communications	Chairman, President, CEO
49	**Delbert W. Yocam**/45	785,679	-14.9%	Apple Computer	Sr. VP, President, Apple Pacific
50	**Scott G. McNealy**/34	781,377	60.3%	Sun Microsystems	Chairman, President & CEO

[1] resigned October 1 1989
[2] resigned July 1, 1989
[3] resigned as director and officer May 15, 1989
[4] resigned October 26, 1989

(Continued)

Top paid U.S. executives

Rank	Executive/age	1989 Cash compensation	Percentage change from 1988	Company	Position
51	**George M. Fisher**/49	776,999	17.7%	Motorola	CEO, President
52	**Donald Dvorkin**/46	763,176	NA	Emerson Radio	Vice Chairman, VP, Secretary
53	**Alan F. Shugart**/58	762,924	0.1%	Seagate Technology	Chairman, CEO
54	**Michael S. Swavely**/36	756,464	8.7%	Compaq Computer	President, North America
55	**E. Gene Keiffer**/60	752,782	22.4%	E-Systems	Chairman, CEO
56	**Gary Stimac**/38	734,650	2.6%	Compaq Computer	Sr. VP, Systems Engineering
57	**Albert A. Eisenstat**/59	734,317	2.3%	Apple Computer	Sr. VP, Secretary
58	**James M. Harris**/46	733,000	13.5%	Compaq Computer	Sr. VP, Engineering
59	**Jean-Louis Gassee**	731,706	-8.5%	Apple Computer	Sr. VP, President, Apple Products
60	**Michael H. Spindler**	712,666	-25.6%	Apple Computer	Sr. VP, President, Apple Europe
61	**James C. Morgan**/51	711,332	22.8%	Applied Materials	Chairman, CEO
62	**Thomas L. Ringer**[5]	707,355	39.6%	Recognition Equipment	Chairman, President, CEO
63	**George E. Safiol**/57	705,834	6.1%	General Instrument	President, COO
64	**Finis F. Conner**/46	704,138	176.8%	Conner Peripherals	Chairman, CEO
65	**Jerry R. Junkins**/52	701,620	-12.1%	Texas Instruments	Chairman, President, CEO
66	**Andrew S. Grove**/53	700,630	-4.9%	Intel	President, CEO
67	**Robert W. Galvin**/67	700,000	0.0%	Motorola	Chairman
68	**C.Michael Armstrong**	680,300	NA	IBM	Senior VP
69	**T.R. Lautenbach**	680,300	-6.4%	IBM	Senior VP
70	**F.A. Mets, Jr.**/56	677,775	-1.7%	IBM	Senior VP
71	**Winston R. Wallin**/63	670,880	17.8%	Medtronic	Chairman, President, CEO
72	**William J. Weisz**/62	668,315	-18.9%	Motorola	Vice Chairman
73	**Gary L. Tooker**/50	668,315	10.3%	Motorola	COO, Sr. Executive VP.
74	**Arnold S. Mazur**	667,961	45.2%	Computer Associates	Executive VP - Sales
75	**William E. Terry**/56	660,136	13.9%	Hewlett-Packard	Executive VP, Director
76	**Lawrence Perlman**/51	657,790	60.6%	Control Data	President, COO
77	**Walter F. Raab**/65[6]	653,814	6.8%	AMP	Chairman
78	**Jack C. Davis**/51	645,890	0.0%	Dataproducts	Chairman, President, CEO
79	**Gordon E. Moore**/61	643,160	-7.9%	Intel	Chairman
80	**Randal W. Chance**/39	631,760	66.6%	Micron Technology	President, COO
81	**James W. Garrett**/41	631,410	97.8%	Micron Technology	Executive VP
82	**Edson D. de Castro**/51	630,231	9.4%	Data General	Chairman
83	**Richard C. Alberding**	622,014	14.1%	Hewlett-Packard	Executive VP
84	**Wayland R. Hicks**	620,140	23.9%	Xerox	Executive VP
85	**Michael R. Ronsignore**	618,521	78.4%	Honeywell	President, International
86	**Raymond R. Martino**/51	611,442	15.7%	Symbol Technologies	President, COO
87	**David A. Bossen**/63	608,075	4.7%	Measurex	President, CEO
88	**William J. Almon**/57	603,469	NA	Conner Peripherals	President, COO
89	**John L. Doyle**	600,366	10.2%	Hewlett-Packard	Executive VP
90	**Bernard S. Appel**	596,791	-3.9%	Tandy	President Radio Shack Div.
91	**A. Lowell Lawson**/52	592,880	16.5%	E-Systems	President
92	**Allan W. May**/42	585,535	NA	Diasonics	Sr. VP
93	**Marcel P.Joseph**/54	581,551	NA	Augat	Chairman, CEO, President
94	**Walter J. Zable**/74	577,111	19.1%	Cubic	Chairman, President, CEO
95	**E. Joseph Zemke**/49	574,541	-37.4%	Amdahl	President, COO
96	**Floyd L. English**/55	573,790	44.7%	Andrew	President, CEO
97	**Gilbert Williamson**/52	571,374	13.8%	NCR	President
98	**Joe E. Chenoweth**	565,228	41.5%	Honeywell	President bldg. automation, defense & marine
99	**Anthony B. Holbrook**/49	556,540	NA	Advanced Micro Devices	President, Chief Technical Officer
100	**Jerome J. Meyer**	536,013	NA	Honeywell	President, Industrial

[5] resigned October 16, 1989
[6] retired January 1, 1990

Source: ELECTRONIC BUSINESS

Viewlogic grows in Europe, protects earnings at home

Innovative financing will be the key for U.S. companies looking to expand overseas by tapping foreign capital

BARBARA N. BERKMAN

Thinking globally is tough for private companies that plan to go public. Any long-term expansion could jeopardize a balance sheet that Wall Street later will scrutinize for short-term profitability.

Financing a major European expansion, for example, is a multimillion-dollar investment. Europe's maze of local markets demands that highly technical products be sold through a direct-sales organization with heavy customer support.

Yet Viewlogic Systems Inc. of Marlboro, Mass., recently crafted an innovative syndication structure that will finance its European expansion without the risks associated with making an initial public offering.

Without the financing, Viewlogic would have lost market share in a booming European market for computer-aided engineering (CAE) tools, now dominated by its competitors. "Daisy, Valid and Mentor make a ton of money here," says Alain Hanover, Viewlogic president and chief executive. "We can make a lot of money here, too."

Viewlogic first had to find financing. "We wanted to invest in Europe, but then Viewlogic wouldn't be profitable," explains Kanti Purohit, president of newly launched Viewlogic Europe BV. Headquartered in The Hague, the new operation is expected to lose money for at least one year.

Using European venture capital, Viewlogic raised $4.5 million for the expansion. The financing is structured so that the U.S. company owns some 20% of its European offspring, and losses incurred abroad will never appear on Viewlogic's balance sheet.

The deal attracted European investors who snapped at the opportunity to finance the expansion. "We are trying to make a profit off the fact that U.S.companies are interested in the European market," says Evert Smid, a partner in Amsterdam with Viewlogic BV's lead investor, Atlas Venture. "There will be more such deals in the future."

Viewlogic is one of a growing number of smaller U.S. companies relying on European venture capital to globalize their operations. "If we couldn't put together the financing, we would have taken a big hit on our profit and loss statement," Hanover explains. For that reason, this syndication "is perhaps a prototype for the future," says Barry Fidelman, Atlas's general partner in Boston.

Typical of fast-growth, globally oriented companies, Viewlogic early on identified Europe as a prime growth market. Lacking funding, it marketed its products in Europe through a distribution chain.

For four years Viewlogic sold its CAE software tools for system, analog, integrated circuit and application-specific integrated circuit (ASIC) design through European distribution channels. The result: European sales never exceeded 14% of total corporate sales of $20 million — European sales were $2.8 million in 1989 — far short of the 25% goal in Viewlogic's business plan.

Viewlogic blames those low sales on the fact that CAE tools must be sold with heavy technical support. Viewlogic managed and supported its distributors out of a sales office in Basingstoke, England, less than an hour's drive from London. But outside Britain, Viewlogic mistakenly "went to distributors for a product that is not right for that channel," Purohit argues.

Not so, says European Marketing & Sales Inc. (EMS) of San Francisco, which set up the Viewlogic distribu-

John Kennard

Kanti Purohit, president of Viewlogic Europe BV: Facing tough competition abroad

tion channel. If Viewlogic had signed a contract for longer than one year at a stretch, argues EMS chairman Pip Smith in San Francisco, the company might have gotten more out of its distributors. "It really can't expect the distributor to invest as much as a parent company."

To boost sales, Viewlogic decided to mirror its U.S. organization in Europe. It hoped to replace most of its distributors with a direct sales network managed by a European headquarters.

Hanover sought out European venture capital to finance the investment. He knew that Atlas Ventures, with offices in Europe and Boston, was one of a rising number of venture capital firms keen to do European expansion financing. He met with Fidelman, the former head of European operations for Data General Corp. of Westboro, Mass., and the architect of Chelmsford, Mass.-based Apollo Computer Corp.'s worldwide sales organization. Atlas also financed the European expansion of Sequent Computer Systems Inc. of Beaverton, Ore.

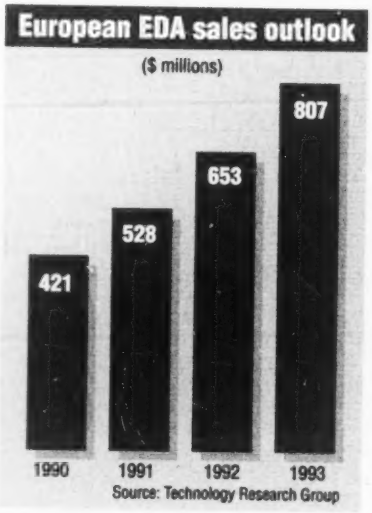
Atlas became the lead investor in the syndication, with $1.5 million in the deal and two seats on Viewlogic Europe's board of directors. It took 18 months of negotiations to hammer out the niggling points of a European business plan: the location of offices, an organizational structure, the legal status of the company, its customer base. The syndication itself wasn't completed until July.

Atlas's Amsterdam branch participated in the due diligence and shopped the deal around Europe. For tax purposes, all potential backers had to be European companies, not majority owned by U.S. investors. And they had to understand, unlike one rejected potential backer that wanted a seat on the U.S. board, that the two companies were separate. Atlas selected fewer than five investors in Europe's key markets of West Germany, England and France.

"It was important to bring in investors local to the major markets who bring contacts and credibility," Fidelman says. Atlas syndicated the deal to venture capital firms Genes of Munich and Partech of Paris, both with $1 million in the deal and a board seat. TVM Techno Venture Management and 3i Ventures of London invested $500,000.

To European thinking, Viewlogic's track record in the United States meant minimal risk. The U.S. company has claimed a compound annual growth of 65% since its founding in 1984, with aftertax profitability of 10%. Its worldwide installed base is 5,000 seats. Viewlogic's standards-based software for front-end tools runs on Unix and DOS-based workstations. It provides a framework for integrating proprietary and third-party tools into one system.

Strong sellers in the United States,



the CAE tools had limited success in Europe. Yet European investors reasoned Viewlogic could penetrate their major countries by leveraging a sound sales base in Britain, where the company already sold directly to original equipment manufacturers and major accounts.

The finance structure allows a return on investors' money as soon as sales hit an agreed-on ceiling. That plateau kicks off a one-to-one stock swap when the U.S. corporation goes public. If Viewlogic BV fails, the U.S. company loses its equity. The European investors take control of the European marketing organization and have complete rights to distribute Viewlogic's products in Europe.

Essential to the structure is keeping losses separate. Viewlogic set up an arm's length relationship between the U.S. company and the European entity. Viewlogic turned away U.S. money and allowed none of its U.S. investors to take part in the syndication. Because the two companies are separate, "we don't have to report the P&L on Viewlogic's books, which will allow us to go public," Purohit says. "When Viewlogic Europe becomes profitable, Viewlogic acquires the European company in a stock swap and I go home."

Purohit will have a tough battle ahead. Purchasing decisions in Europe can take 18 months — much longer than in the United States — which stretches out the period it takes to build sales volume. Viewlogic also lacks credibility in a European market dominated by industry giants Mentor Graphics Corp. in Beaverton, Ore.; Valid Logic Systems Inc. in San Jose; and Daisy Systems Corp. in Mountain View, Calif. —all with well-established European direct-sales forces.

The Netherlands is home to Viewlogic's manufacturing and distribution headquarters. Sales offices are in Britain, West Germany, France and Italy. The Basingstoke office is home base for a training center and eight salespeople who sell directly to accounts in Britain. Plans also call for a pan-European OEM liaison and one person to manage the distributors. Continentwide, there will be up to seven sales teams, each made up of a salesperson and applications engineer. The rest of the capital is budgeted for a customer-support organization, training centers, customer response centers and a continentwide consulting network.

Viewlogic also is relying on well-known Europeans to carry its tools to European customers. It has agreements with Plessey Semiconductors of Irvine, Calif., and SGS-Thomson Microelectronics of Carrollton, Texas, to bundle its tools with their software packages. SGS-Thomson recently developed a semicustomized mixed analog/digital design kit based on Viewlogic's Workview tool set.

The European setup is part of what Hanover calls "our strategic intent to be a global company." Viewlogic drove home that message to Marlboro employees at a recent company celebration when it hurled around hundreds of beach balls emblazoned with a world map. Employees get other reminders. Purohit plans to send all European employees to the United States for immersion in the U.S. company's culture. □

ATE leaders get competition from below

Faced with competition from low-cost suppliers, vendors of high-performance automatic test equipment are rethinking strategies

BY PETER BURROWS

The automatic test equipment (ATE) industry saw some unsettling market trends develop in 1989. Traditionally in the business of supplying high-priced, high-performance machines, manufacturers watched lower-cost competitors reap big profits in a year in which overall ATE sales were slightly down.

To a growing number of observers, the implications are clear: Customers are increasingly willing to trade sheer functionality for test equipment that enables them to cut costs and reduce time to market.

"Test is taking up an unreasonable proportion of the development process these days, both in terms of time and money," says consultant Jon Turino, president of San Jose-based Logical Solutions Technology Inc. He estimates that test can account for up to 45% of development costs in both time and money, up from 20% five years ago.

As a result, many customers are looking for new ways of handling test. "The days of the $3 million tester that takes two weeks to program are a thing of the past, except in massive, single-part operations," says Eric Brysk, research analyst with Boston-based Technology Research Group. Instead, growing numbers of customers are opting for less superpowered solutions in favor of "best fit" technology that takes full advantage of customer attempts to improve their manufacturing methodologies:

- Manufacturing-defect analyzers costing under $100,000 and real-time X-ray inspection systems are slowly eating into the pricier in-circuit board test market.
- A new generation of sophisticated mixed-signal testers featuring modular architectures have attracted customers in search of the cheapest configurations possible.
- ASIC (application-specific integrated circuit) verification systems, costing between $200,000 and $800,000, are replacing $1 million-plus low-end ATE in low-volume production test environments.
- Low-cost, stripped down component and board testers are rapidly gaining ground in selected niches.
- Even the secondary market in used equipment is thriving as the industry's middle class tries to hold down costs.

The highest sales growth in 1989 was for low-end semiconductor testers costing under $600,000, which were up 61% over 1988, according to San Jose-based market researcher Prime Data. Sales of ASIC verification systems, increasingly used for production test, were up 34% for the year. The entire ATE market, meanwhile, slipped 2.3% from $2.1 billion in 1988 to $2.05 billion last year; semiconductor test as a whole was down 3.1% to $1.2 billion, and board test was down 1.2% to $670 million.

The companies who are cashing in on this customer thriftiness, such as Credence Systems Corp. of Fremont, Calif., Integrated Measurement Systems Inc. of Beaverton, Ore., and Megatest Corp. of San Jose, share a price-driven approach to selling test equipment.

"Everyone has access to the same technology, but most people use it to drive out the last picosecond of performance," says Woody Spedden, director of sales and marketing at Credence, which has grown 34% over the past two years by selling systems highly optimized to test certain high-growth classes of semiconductors such as ASICs, application specific standard products (ASSPs) and field programmable gate arrays (FPGAs). "We use technology to help us drive down the cost of test. We decide what the customer absolutely needs in a specific area, and don't put in anything more than that." Credence claims cost-per-pin of $2,500 for its systems, while industry standards range from $7,000 to $12,000.

Most established ATE players dismiss the significance of these lower-cost

Meeting the ASIC Challenge

The growing market for application-specific integrated circuits (ASICs) is creating opportunities for a new brand of test equipment. Use of these semicustom chips, which should increase from about 10% of all semiconductors used in 1989 to about 20% in 1995 according to Boston-based market researcher Technology Research Group, enables customers to easily differentiate their products by frequently changing chip content and capability. As a result, test equipment vendors are having to deal with customers' growing need for high design throughput rather than just high production throughput. ASIC use puts a premium on how quickly manufacturers manage processes involving production runs in the thousands rather than millions.

ASIC verification systems are meeting that need for many customers at the expense of low-cost ATE. Sales were up 34% in 1989 — a year in which overall ATE revenues fell by 2.3%, according to San Jose-based Prime Data. Originally designed to give product engineers a way to make sure their prototypes did what they were supposed to, a growing number of test engineers have found ASIC verifiers to be an economical and efficient way to inspect incoming supplies and do low-volume production test; not only can they be reprogrammed in days rather than weeks when a new device hits the production line, but they often sell for 20% of the cost of full-blown ATE.

Most ASIC verifiers fall well short of ATE in terms of throughput and functionality, "but many customers are willing to do without if it means $500,000 or $1 million in savings," says Jim Davis, director of Hewlett-Packard's semiconductor systems center in Santa Clara, Calif. "It's often better to buy two cheaper machines rather than one big machine that may not be used at capacity... You can save a lot of money in not having that jumbo just sitting around doing nothing, and you won't have to shut everything down if your only tester breaks."

Davis claims that H-P has a 70% winning record in the 5% to 10% of sales situations in which ASIC verifiers compete against traditional ATE systems. Bjorn Dahlberg, president of Hilevel Technology Inc. of Irvine, Calif., says that about half of his company's sales come at the expense of ATE — much to his surprise. "We are an instrument maker," says Dahlberg. "We are not going after the ATE market, but more and more we find ourselves in competition with them."

Integrated Measurement Systems, which now shares about 75% of the $75 million ASIC verification market with HP, does not shy away from its opportunity to attack the $2 billion ATE market. "We're going to make a frontal assault on a range of test areas — verification, failure analysis, incoming inspection, printed circuit board verification, quality assurance, low volume wafer probe/sort, and even low volume production test," says director of marketing Steve Morris. "We're really arguing for a resegmentation of the test market. There's been a fundamental shift in the IC market, but ATE hasn't shifted with it." □

ATE market breakdown

Only growth in the low end
($ billions)

	1989 Sales	1989 Growth rate
ATE overall	$2,047	-2.3%
ASIC verification system	$59	14.5%
Low-cost device test (under $600,000)	$145	61.1%

Source: Prime Data

rivals as reasonably well-executed nichemanship. But by some observers' calculations, the popularity of competing test strategies is a more ominous threat to vendors who have long relied on low-volume sales of high-priced product. "As customers look to add capacity, they can either buy another $2 million tester or they can take a look at some new $40,000 solution," says Stephen J. Balog, a vice president with Lehman Brothers in Manhattan. "More and more price points are developing as the testing business expands, and people don't have to just go with the Rolls Royce anymore... And you can buy an awful lot of jeeps for the price of one Rolls Royce."

In the past 18 months, ATE's market leaders have begun to respond to changing customer requirements. Boston-based Teradyne Inc., LTX Corp. of Concord, Mass., Tokyo-based Advantest Corp. and Schlumberger Technologies of San Jose have all offered scalable architectures on certain high-end products that can be configured to meet customer needs, and all offer or are developing software packages that reduce test-related problems by simplifying test program development and tying it more directly to CAD/CAM/CAE systems.

EDA competition

But with no elemental changes in test technology on the horizon, ATE companies are finding themselves in competition with front-end design automation companies intent on moving testability issues upstream. Such EDA vendors as Cadence Design Systems Inc., Mentor Graphics Corp. and Racal-Redac Corp. have invested in or forged agreements with design-for-testability technology vendors in an effort to help their customers reduce testing costs by simplifying the test process.

Most ATE vendors say that these developments will spur ATE's popularity by enabling customers to use their test equipment more efficiently, but others worry that customer enthusiasm for emerging front-end technologies will drain dollars from test budgets. "You have to wonder whether the growth in design automation, design for testability, and ASIC verification hasn't been at our expense," admits Steve Harari, North American director of marketing for Schlumberger's ATE division.

Numbers from market researcher

VLSI Research Inc. bear out these fears: While test budgets are expected to increase by 12.2% annually from 1990 to 1995, investment in front-end technology will increase by 14.5% per year, says VLSI analyst Jeff Burke: "Hey, it's getting harder to make chips in the first place, so people are dumping more of their money into wafer fabs. The basic reasoning is that if you can't make the chip, who cares if you can test it."

With fewer dollars available in test budgets, ATE vendors are under severe pressure to provide more bang for the buck. "Customers have driven our expectations on pricing way down," confirms Tom Coughlin, director of marketing at GenRad. "The cost per test function has already gone down. What you can get for $300,000 today is an order of magnitude better than what you could have gotten three years ago."

And these shifting spending patterns also portend changes in the way customers use test equipment that could further erode unit sales. "The leading-edge companies are all convinced that the design phase is the best place to get rid of defects," says Coughlin, "and this will allow them to weed out manufacturing defects." As such, yields will go up, reducing the need to test every single device that comes off the line.

Finding common ground

While ATE companies including Teradyne, GenRad and Hewlett Packard Co. have been directly competing in the EDA industry in recent years, few observers feel that this is a requirement for ATE success. "But we have watched the design companies creep into our territory, and it behooves us to build some front-end capabilities into our systems," says Schlumberger's Harari. As a result, ATE companies are putting greater emphasis on integrating their equipment more seamlessly with the total manufacturing process:

- Since almost two thirds of customer testing costs typically go into test program development, vendors have focused on offering sophisticated software capabilities that link the test equipment closely with CAD/CAM/CAE systems. In some cases this means offering test programs that are easily understood by product designers, rather than the cryptic languages normally used by test engineers; in others, it means adding modules that automatically convert simulation vectors into forms that test equipment can use without time-consuming translations.
- With more and more devices equipped with scan circuitry and other design-for-testability technologies, most ATE vendors are offering optional modules equipped to make use of these new capabilities.
- Since customers who use ASICs customize their products more often than those who use only standard products, ATE vendors are offering software that cuts down the time it takes to set-up test equipment for new production runs.

ATE vendors are under severe pressure to provide more bang for the buck

The merging of test and design is also resulting in some innovative business partnerships. Schlumberger, for example, is involved in a $4 million-plus venture with Motorola Inc. to design ATE systems that make the best use of advanced scan technologies, as well as a joint venture with Nippon Telegraph and Telephone (NTT) called Verisys Inc. that has developed cutting-edge ASIC verification systems for use in R&D labs.

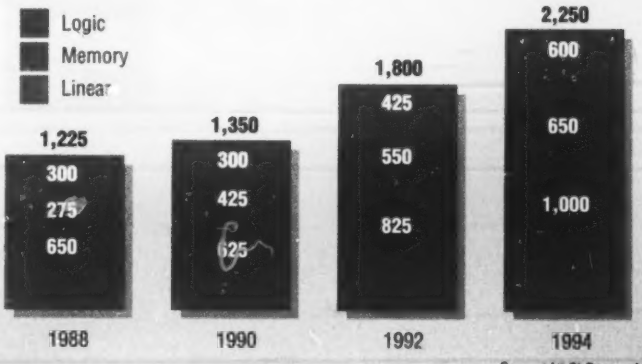
While pundits are quick to dismiss the "million-plus dollar tester" as dead and buried, vendors and customers say that constantly rising product complexity ensures a future for traditional ATE strategies. Sales of memory testers in this price category, for example, doubled in 1989, according to Prime Data.

"There are still two ways of doing things — either quick and dirty or with great thoroughness," according to Steve Bisset, vice president of advanced projects at Megatest Corp. "But with increased complexity, it becomes more incumbent to go the thoroughness route." While he does agree that the price of some of the current generation high-end systems must come down, Bisset scoffs at the idea that they are somewhat of an endangered species. "That's like saying there is no difference between changing a tire on a VW bug and on a 20-ton tractor trailer. The fact is that the low-end competes with the low-end and the high-end competes with the high-end; customers will always buy the technology they need to do the job."

True enough. But chinks are appearing in the traditional high-performance, high-price approach to ATE, especially for United States vendors. Neither GenRad, LTX, Schlumberger or Teradyne — America's top three ATE-only suppliers — made a profit last year. Is it time for a new measure of success in ATE? □

ATE market to improve

Total market to grow 10.7% annually from 1988 to 1994
($ millions)



Source: VLSI Research Inc.

For single-board makers, the future is Futurebus+

With the shift to open-standard platforms and development of a new bus architecture, system makers will rely more heavily on third-party vendors

BY GIUSEPPE LABIANCA

As users' demands for open-standard architectures increase, rival computer makers are cooperating to create a new open bus architecture — Futurebus+. Single-board computer makers have the most to gain from the move away from proprietary architectures.

Competitive computer makers like Digital Equipment Corp., Hewlett-Packard Co., Intel Corp., Motorola Inc., Sun Microsystems Inc. and Unisys Corp. are working together on the specifications for a next-generation, high-performance, open-standard bus architecture. Dubbed Futurebus+, the new bus architecture features a 64-bit data path which is scalable to 256 bits, a larger form factor and faster clock rate, while having the advantage of being an off-the-shelf bus. It will allow computer makers to take full advantage of the faster, more powerful microprocessors being produced while allowing more functions like graphics to be integrated on a single board.

Nearly all the major participants in the computer industry are helping to create the specifications, and some are already working on their first Futurebus+ products. But because the specifications are still being worked out, the earliest of these products will not be ready until late 1991 and volume production will not begin until 1994 or 1995. Maurice Klapfish, vice president of Venture Development Corp. in Natick, Mass., projects 80% annual growth between 1991 and 1994, by which time time the Futurebus+ market total $233 million.

"Futurebus+ has caught on like wildfire," says Steph Rutel, manager of product marketing at Campbell, Calif.-based Force Computers Inc., which claims to be the largest independent VME board maker with revenues of over $50 million. Ray Alderman, technical director for the VMEbus International Trade Association (VITA), says, "semiconductor makers are all over this technology, so the silicon structure is there. System makers are extremely active as well."

Motorola, the largest VME board maker, is currently working on Futurebus+ products for introduction by late 1991, according to Shlomo Pri-Tal, director of strategic marketing for the microcomputer division. Initially these system-level products will be used in high-end servers and for fault-tolerant solutions, says Pri-Tal. He predicts it will be a few years before Futurebus+ migrates down to board-level products.

Force's Rutel says the introduction of Futurebus+ will place computer makers into more direct competition because their customers will no longer be forced into loyalty by being locked into a proprietary architecture. Increased competition will most especially be evident between semiconductor makers and large system makers like DEC and Sun. "The semiconductor makers like Intel, Motorola and National are going to step on their own customers as they jump on board the Futurebus+ bandwagon to compete," he says.

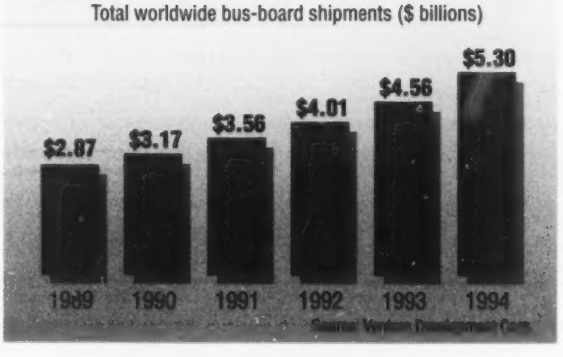
The people who will benefit most from the move to Futurebus+, though, are the independent single-board computer makers, says Paul Borrill, director of S-bus architecture and support group at Sun Microsystems Inc. Borrill says that as more slots are created for Futurebus+ by system makers, they will turn increasingly to independent board makers to provide off-the-shelf boards as a way to reduce research and development costs associated with a new architecture.

"Because new microprocessors are outperforming minicomputers, computer makers like DEC, Amdahl and Hewlett-Packard are finding that there is not much value they can add in hardware," says John Hyde, Multibus II architecture marketing manager for Intel Corp.'s microcomputer division in Oregon, which manufactures board-level computers. He adds that the system makers will buy open-standard platforms built by others and then place their systems on them.

It is natural for independent board makers to move from providing bus boards for smaller customers in industrial automation and communica-

Board market grows steadily

Total worldwide bus-board shipments ($ billions)



tion to building input/output and memory boards for large system makers like DEC and Data General, says Christopher Koehle, product marketing manager for Futurebus+ at National Semiconductor Corp., which is producing an interface chip set for Futurebus+. "The independents will have the same type of market they have now for VME, except much larger because the computer makers are all converging on the same standard," says Koehle.

Shift to open standards

Motivating the push for Futurebus+ are users' demands for open-standard architectures. Carlo Bruno, U.S. national sales manager for Ottawa, Canada-based military boardmaker Dy-4 Systems Inc., says Intel did a good job of developing board-level products, which were based on their Multibus II architecture. But, he adds, Intel did not make enough of an effort to position Multibus as an open standard. Bruno believes that Motorola's decision to allow its VMEbus to be a more open architecture has contributed to its market success. But now customers have come to expect open architectures, says Bruno.

Force's Rutel adds, "nowadays, it just doesn't pay to tie into proprietary architectures." Motorola's Pri-Tal agrees: "We expect a shift from proprietary systems built around closed architectures to Futurebus+ in the next few years. Our users want standards. A standard allows them the flexibility to unplug a unit with a [68030 microprocessor] and plug in an 040. Complying with open markets allows customers to change vendors whenever they like."

Reserving judgment

Despite the excitement surrounding Futurebus+, some board-level makers reserve judgment on how much of an effect its introduction will have. Futurebus+ is intended to be the next-generation VME to which single-board vendors will eventually migrate. But that will not be the case for everyone, predicts Abe Hirsch, director of marketing for Heurikon Corp., a Madison, Wisc.-based board maker with more than $20 million in yearly revenue.

Hirsch says Futurebus+ will be very expensive, while 32-bit boards are still quite viable and much lower in price. The introduction of Futurebus+ will not make the VMEbus obsolete, he says. "OEM products have longer product life-cycles today because people are writing more software for these products." The higher software investment, as well as the trend towards more application-specific products at the CPU level, have translated into longer production runs, adds Hirsch.

According to one computer industry executive, Futurebus+ is being developed for those users on the "lunatic fringe" who need the highest performance, whatever the cost. With bridge specifications between Futurebus+ and VME still being worked out, it is expected that the two buses will coexist. Force's Rutel says, "VMEbus will not fade away, just like Multibus I didn't before it. It will just serve a different market, one that requires lower performance at a lower price than Futurebus+."

Joel Silverman, marketing manager for commercial products at Radstone Technology Inc., says that VME is getting a mid-life kick which will allow it to double its data path from 32 to 64 bits. "That should help bridge the gap until Futurebus+ comes around," according to Silverman.

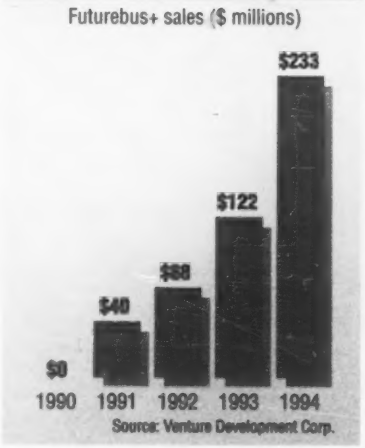
Some board makers worry that despite the open architecture, systems makers will limit the type of boards they are able to produce. Pete Yeatman, the new president of Radstone Technology, Dy-4's major competitor in the military market, says that the large computer companies will continue to treat Futurebus+ only as an I/O bus. "The piece that DEC and the others will allow the world is small," says Yeatman, adding, the marketplace will be no different than the current market, though there will be a larger vendor availability. Intel's Hyde stresses the same point: "I've no premonition we will sell CPU boards to the DECs and the Amdahls, but we will sell standard boards like I/O boards to them."

Off-the-shelf advantage

Sun's Borrill agrees that DEC has had a very restricted attitude towards letting the independent board makers provide anything more than an I/O board. He attributes this to their traditional reliance on proprietary architectures. He says Sun is not concerned with proprietary advantage, and will not restrict the board makers. He says eventually all system makers will be forced to draw the same conclusion — it is much more economical to buy open-standard boards off-the-shelf than it is to design them.

Meanwhile, the single-board computer market is comfortably and consistently plugging along at an annual growth rate of 13%. Force's Rutel says that when the computer industry is slumping, computer makers look to reduce costs by turning to single-board makers. Single-board computers allow you to trade a little customization to get faster time-to-market. You can also focus your R&D dollars on designing other aspects of the system, says Rutel. □

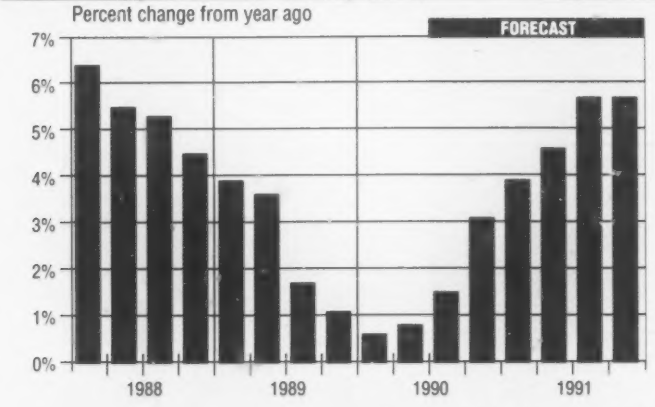
Futurebus+ growth



Futurebus+ advantages

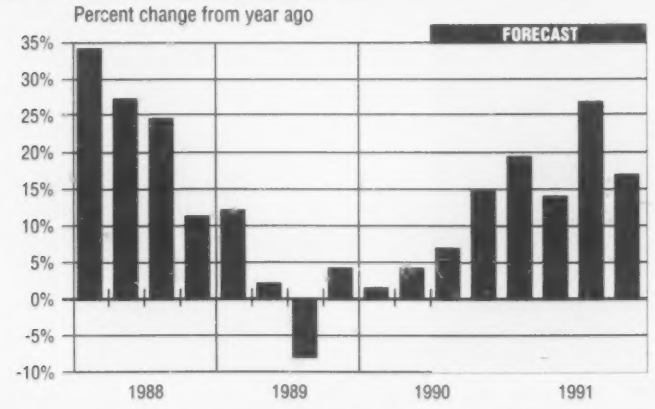
- A 64-bit architecture, scalable to 256 bits. Current VME data width is 32 bits.
- Faster clock speed: Internal data transfer at 400 megabytes per second, compared with about 40 megabytes per second for VMEbus.
- Larger form factor: By using a bigger board, it lets more functions be placed on a single board.
- Open-standard architecture means no license fees for users who may change vendors at any time.

Strong U.S. industrial production...



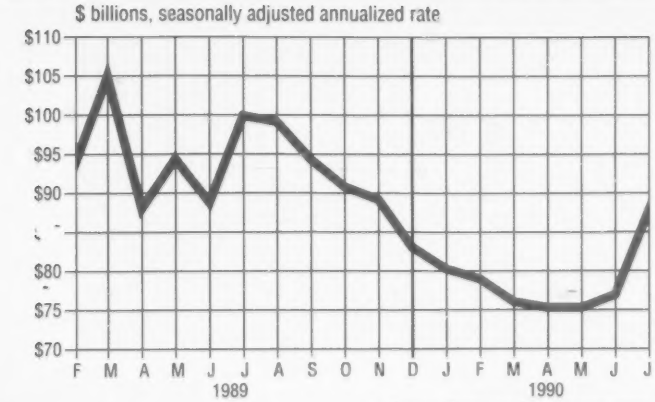
Source: U.S. Federal Reserve Board

...means improving U.S. semiconductor bookings



Source: Semiconductor Industry Association; Forecast: Cahners Economics

...and higher semiconductor prices



Source: *Electronics Purchasing* magazine

Business cycle brings semiconductor turnaround

After many months of slumbering, the worldwide semiconductor industry is beginning to wake up. The cyclical rebound in semiconductors bodes well for future gains by computer and electronic equipment manufacturers in 1991 as well.

Here's the evidence for the semiconductor rebound:

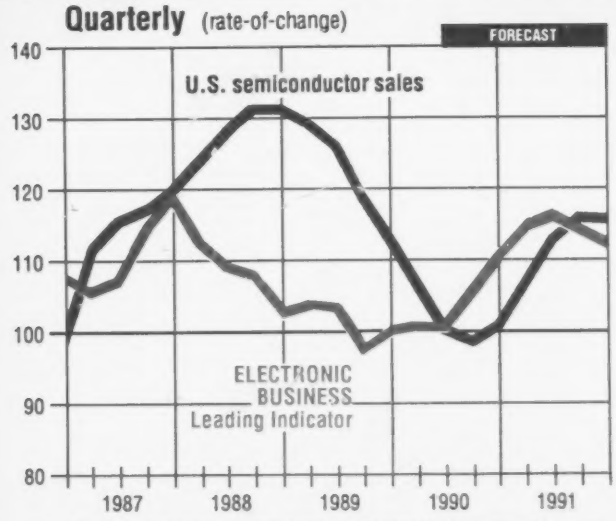
- U.S. industrial end-markets are healthy and have successfully averted a recession. This means demand for high-tech capital equipment will be stronger in 1991, especially with interest rates lower now. Purchases of components to build this equipment are beginning to show signs of increase. The only end-market that semiconductor producers won't see grow next year will be the defense sector.
- Several key leading indicators for semiconductor sales have been heading upward ever since the first quarter of this year. Growth in semiconductor bookings, hours worked by semiconductor production workers and Standard & Poor's stock price index for semiconductor companies all are pointing upward.
- Semiconductor prices have finally stopped falling. Surveys of the prices U.S. buyers are paying for integrated circuits show that the rapid price decline of 1989 and early 1990 has bottomed out and prices are holding steady. With firmer prices, dollar sales of semiconductors will begin to strengthen. Until now, unit sales growth had been faring much better than the total 1990 sales.

Recent evidence confirms the turnaround in the semiconductor marketplace. Bookings for chips in North America totaled $1.27 billion in June, down from $1.38 billion the month before. But for the three-month period ending June 1990, bookings had risen 4.3% above year-ago second-quarter figures. This gain confirms the fact that the 12-month slump is over.

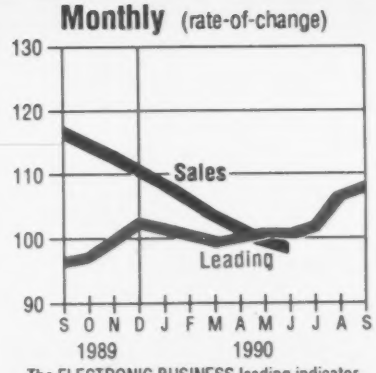
Cahners Economics' forecast for semiconductors remains virtually unchanged from the previous report (ELECTRONIC BUSINESS June 11, 1990, pg. 90). The latest data was right on track with our near-term forecast. Expect North American semiconductor sales to grow at a meager annualized rate of 0.6% by the end of 1990, with significant growth in the final quarter of this year. The forecast calls for a hearty 15% gain in 1991 as new product introductions, firm chip prices and stronger end-market demand produce positive results for semiconductor company balance sheets next year.

ELIZABETH B. BAATZ, Cahners Economics

ELECTRONIC BUSINESS leading indicator



To obtain your complimentary copy of a 12-page background paper on the ELECTRONIC BUSINESS leading indicator, please contact Linda Spiller at Cahners Publishing Company, 275 Washington St., Newton, MA 02158-1630, USA, telephone (617) 558-4397, fax (617) 558-4402.



The ELECTRONIC BUSINESS leading indicator was steady from May to June in at 100.7 in both months. Semiconductor bookings decreased 8% from $1.38 billion in May to $1.27 billion in June. This slight drop was offset by a rise in the S&P semiconductor stock price index from 74.6 in May to 79.7 in June. This is the highest the index has been since September 1987 when it peaked at 82.07. The leading indicator is forecast to post a steady climb in the second half of this year and reach a peak level of 116 in June, 1991.

Source: Cahners Economics

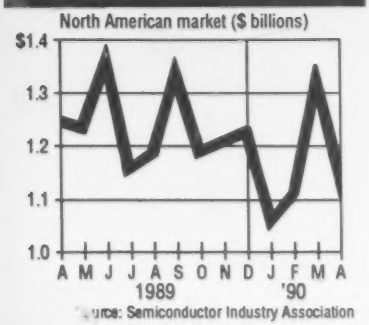
Electronics industry indicators this month

	Latest month	Previous month	Year ago	1989 average
ELECTRONIC BUSINESS leading indicator (rate-of-change, June)	100.7	100.7	101.8	100.9
U.S. semiconductor bookings ($ millions, 3-month average, June)	$1,270	$1,380	$1,254	$1,205
Weekly hours of semiconductor production workers (monthly average, May)	40.5	40.9	39.6	40.1
Electronic component leadtime index (1977=100, July)	82.7	82.4	107.4	102.5
S&P's semiconductor stock price index (1970=10, monthly average, June)	79.7	74.6	57.6	54.7
Change in electronic components inventories ($ millions, SA, May)	+$84	+$63	-$78	-$12.8
Contracts and orders for plant and equipment ($ billions, SA, May)	$40.6	$41.0	$41.9	$43.4

SA = seasonally adjusted, all other data are not seasonally adjusted

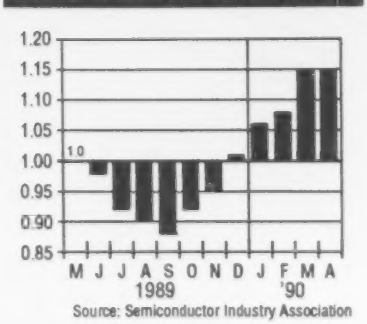
Sources: Semiconductor Industry Association, U.S. Bureau of Labor Statistics, *Electronics Purchasing* magazine, Standard & Poor's, U.S. Commerce Department, U.S. Bureau of Economic Analysis

Semiconductor sales



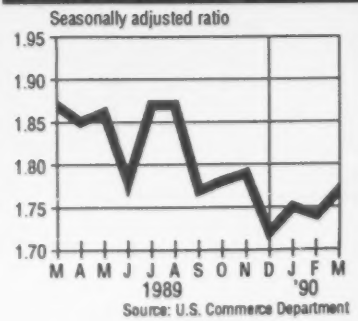
Source: Semiconductor Industry Association

Semiconductor book-to-bill ratio



Source: Semiconductor Industry Association

Component inventory-to-shipments



Source: U.S. Commerce Department